

VITALISM: A BRIEF HISTORICAL AND CRITICAL REVIEW (I.).¹

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DESIRE to know the purport and causes of vital phenomena—life's why and how—is the invariable starting-point of those vast systems of speculation which from time immemorial the human mind has been framing in an unwearying endeavour to determine its relation to the external world. Of these systems it would at first sight appear that there are three distinct kinds—those of Theology, Metaphysic and Natural Science, and that each of them deals in its own fashion with the problems of nature. Indeed to many writers so different have seemed the methods severally employed and the teachings thereby deduced, that, taking for granted the unity of Truth, they have held that, while Theology, Metaphysic and Natural Science may all be wrong, not more than one of them can conceivably be right in the course pursued to effect a solution.

The Theologist regards the study of life as part of the study of soul. Present existence is for him a mere phase among such past or future states as are upheld in the doctrines of palingenesis, metempsychosis or resurrection. This standpoint, from its very nature forbidding criticism, contrasts with that of Metaphysic or of Natural Science, each of which is based upon independent judgment instead of upon authority. Among themselves Metaphysic and Natural Science have differed, in that the former has relied mainly upon reason, the latter mainly upon experience. "Perceive," says Natural Science, "conceive, then verify by further perception." From the extremes of metaphysic, beyond the reach of experiment, has rather come the retort: "Conceive and rest satisfied with conceptions". Carrying her distrust of the senses into the realms now held by Biology, Metaphysic has at times ventured to speculate on life's nature in the light of reason more or less purified from the dross of ex-

¹ An essay (here slightly modified and abbreviated) which obtained the award of the Arnold Gerstenberg Studentship, Cambridge, 1896-7.

perience. She has endeavoured generally to solve the problem of the external world from the inner knowledge of the Ego. It is sufficiently correct to say that the progress of Natural Science—as witnessed, for example, in physiological psychology—depends on the pursuit of a diametrically opposite course.

History shows how often Theology, Metaphysic and Natural Science have in turn overstepped their boundaries, carrying a war of the fiercest controversy into the territories of their respective neighbours. While Theology necessarily remains to some extent isolated as the voice of Authority, in the relation between Metaphysic and Natural Science a new era seems clearly dawning. The once hard line of demarcation between the vaunted simplicity of scientific empiricism and the transcendentalism of metaphysical speculation is fast fading. The shallow one-sided views afforded by either, unaided by the other, are giving way before their far more suggestive combination in a picture of truly stereoscopic solidity. How Metaphysic has influenced Natural Science is well seen in the modern conceptions of potential energy, action at a distance, atoms and ether. How Natural Science has reacted on Metaphysic, the present position of Psychology sufficiently testifies. Hereafter it appears that the search after the nature of vital phenomena is yet another of the many paths wherein the interests of Metaphysic and of Natural Science intersect.

PART I.

A HISTORY OF VITALISTIC THEORIES.¹

In ancient Greece lies the starting-point of the earliest philosophy from which the principles of Natural Science can be derived ; where the conditions, alike of climate externally and internally of society, tended rapidly to develop the independent spirit of rational inquiry.² Eager to step beyond religion and to explain all external phenomena by the aid

¹ By Mechanism is understood the description of the phenomena of life in terms of processes already revealed by the study of lifeless nature. When the aid of some hyper-mechanical process is invoked, Vitalism replaces Mechanism. Vitalism includes Animism and Vitalism proper : the former implying the direction of an anima or soul, the latter that of numerous hyper-mechanical forces or principles.

² Zeller (1) seems to have effectively opposed the contention of Roth and Gladisch that this early Grecian thought was in the main a product of Hebraic, Egyptian and other Oriental influences.

of reason, the early Greek set forth on his journey, equipped only with a Fetishism which under the cloak of Religion had lovingly been fastened on to him from infancy. With this, the one weapon of which he knew the use, he was quickly forced to fight in his spirited battle against the great Unknown. In turn he endowed water, fire and earth with the necessary life-creating principle or *ἀρχή*. When soon it became clear to him that principles like these could not exist, he appears to have treated elements as mere symbols of the principles. Abstraction thus started grew apace. Beside the Physical arose the Mathematical School, which, putting implicit faith in the truth of mathematical language, proclaimed numbers to be the principles of Things, Life and Soul to be the manifestations of Numbers, and Numbers to have actual existence.

Heraclitus and Empedocles (fl. 475 B.C.) by their inquiry into knowledge itself, did much to hasten the establishment of more clearly stated speculations on the nature of life. From Heraclitus arose the atheistic or rather pantheistic conception of instability. Everything is in constant motion. He sets up a fate or *εἰρμαρμένη* as director of this perpetual flux, retaining, however, the everlasting fire (*πῦρ αἰεζῶν*) to explain all vital phenomena. *Αὐγὴ ξηρὰ, ψυχὴ σοφωτάτη*, “the purer the fire, the more perfect the soul”. “A drunken man has a moistened soul.” Empedocles, so far as his doctrine of a rival love and hatred are concerned, makes a near approach to Dualism. Moreover, the assertion to him accredited, that living beings are created by the accidental union of neckless bodies, bodyless legs and similar monstrosities previously shaped by the mutual attraction and repulsion of the four elements, is one far ahead of his time.

Anaxagoras (500-428 B.C.) deserves mention not only for the originality of his views but as the master of Socrates who led to the foundation of the school of Attic philosophers. Water, fire and earth were to his mind the components of the primitive matter from which the body is formed. Confident that matter can never explain its own properties, Anaxagoras endowed it with a *νοῦς*, the most subtle of all things, having the most knowledge and the greatest strength.

Even in Hippocrates (460-377 B.C.) there is little enough from which one may deduce a definite theory on the nature of vital phenomena. When the most conflicting opinions prevail as to which of his books are and are not genuine,¹ it

¹ More than fifty pretended works have come down to posterity; of these nineteen are accepted by Mercuriali, and only five by Grimm. One commentator, stating that Hippocrates paid little or no attention to the

only remains to present the generally received notions of his views. In a well-known passage, Hippocrates ascribes the essence of life and the cause of all its phenomena to the ether, the subtle fire which has existed from all eternity and is present in air and all matter. This fire or ether, which seems identical with the pneuma elsewhere described, is immortal, knowing, seeing and hearing all. It knows the present, past and future; it arranges everything, working noiselessly, being neither tangible nor visible. The pneuma changes between the lungs and the blood, between the blood and the tissues: the brain communicates with it freely. Soul and life seem to be made up of this atmosphere, which diffused through nature is single in essence though manifold in qualities.

At length we come to him who was the first clearly to separate mind from body, who enlarged thereby the whole field of philosophic inquiries—Plato (427-344 B.C.). Because of the far-reaching influence which his cosmogony held over his own and on long subsequent physiology, a clear account of the Platonic philosophy would have great value. The task, however, is well-nigh impossible amid so much allegory, so marked a want of coherence, and such frequent contradictions as are found scattered throughout his works. Plato has been excused these obscurities on the ground that they in reality express the scepticism of the Socratic school to which he belonged. Whether this be so or not, the result has been that each age places a different interpretation on his works. The system of Plato is founded on the distinction between Being and Not-Being, and the universe is accordingly divided into a region of noumenal intelligible Ideas and a region of phenomenal sensible matter. Ideas alone have true Existence. Phenomena are considered as lying midway between that which has and that which has not Existence. At the opposite extreme of Being stands that “which is at once the groundwork and the receptacle of all Becoming, the common element which underlies all corporeal elements and all determinate matter”. (2) Whether this groundwork of phenomena was conceived by Plato as a material substance has been disputed. But surely the admittedly unknowable nature of the Not-Being demonstrates its formlessness. Plato has often been credited with the separation of soul from life in contradistinction to Aristotle who, it has been said, maintained that they were one. Yet in the *Phædo*

causes of life, places the *De Natura Homin.* as late as Herophilus. Haller denies the Hippocratic source of the *De Significat. Vitæ et Motus.*

occurs the passage, "What causes the body to be alive?" and the reply is that it is the soul and always the soul that carries life with it wherever it enters. Soul is divided by Plato into Reason, Courage and Desire, respectively seated in the head, the breast, and the lower regions. He divides the soul into two mortal (noble and ignoble) parts and an immortal part, the dwelling-places of which in the body, like the bed-chambers of men and women within the house, are kept separate. Plato ascribes to the Soul immortality, transmigration, pre-existence and recollection (*ἀνάμνησις*). He bases its immortality on its survival from evil which kills all else. He is probably serious in adopting the Pythagorean theory of transmigration. The doctrine of recollection by the Soul of its former experiences forms a necessary support for the development of the Platonic conception of ideas (2).

In Plato's pupil, Aristotle (384-322 B.C.), is seen for the first time a dim possibility of the ultimate separation of metaphysical from scientific method. By his collection of diverse scattered physiological phenomena, he laid the foundation of a science whose scope and object were finally clearly recognised. Aristotle, after criticising Plato's system, seized on the difference between the potentiality of Matter and the Actuality of Form, and proclaimed that all substances have arisen from the combination of Matter (*τὸ ὑποκείμενον*) and Form (*τὸ τί ἦν εἶναι*). Life, says Aristotle, has substance, and the Form of Life is the Soul. Everything possessing a Soul is alive; the Soul is the principle of movement, without admitting in itself of movement. The hypothesis of the union of Soul with Body is discarded. In the System of Aristotle the latter serves merely as an end to the former. Mankind is distinguished by a *νοῦς*, a part of the Soul, unlike the other parts in its immutability and knowing neither birth nor death. The soul has its seat in the Pneuma (which is the cause of vital heat) and resides in the heart. The plant has but one Soul, the Constructive Soul; the animal has the additional Souls of Desire, Sensation and Locomotion. Finally in man is consummate the Soul of Reason.

The combined influence of Aristotle and Plato on the followers of the Hippocratic school led to a gradual development of the infant doctrine of the pneuma. Herophilus (fl. 300 B.C.) taught that the pneuma produces four kinds of movement, two of contraction and two of dilatation, and that correspondingly there are four powers (*δυνάμεις*) of animal life, nourishment in the liver, warmth in the heart, thought in the brain and sensation in the nerves. His contemporary, Erasistratus (fl. 250 B.C.), distinguished a *πνεῦμα ζωτικόν* in

the heart from a *πνεῦμα ψυχικόν* in the brain, and, refuting the internal perfecting principle of Aristotle, denied the current Stoical belief in the rule of a wisdom of Providence over the body.

The school of the Pneumatics proper finds its ablest exponents in the persons of Athenæus, Aretæus and Archigenes. Athenæus of Attaleia (fl. 50 A.D.), adding to the two pneumata of Erasistratus a third, the *πνεῦμα φυσικόν*, maintained that disease resulted from certain changes in the pneumata. It is here unnecessary to refer to the clinical observations and teaching of Aretæus (fl. 150 A.D.), and Archigenes, close followers of Hippocrates. The pneumatic doctrine received its fullest development at the hands of Galen, beneath the shadow of whose authority it was destined to flourish for many centuries.

Claudius Galen (131 to about 200 A.D.) was the first in the history of Natural Science in whom an honest desire is found expressed to collect all phenomena into a mutually dependent system before the construction therefrom of philosophical speculation be attempted. Grasping the importance of anatomical research as a basis for the comprehension of physiological function, Galen undertook the dissection and (we are told) the vivisection of various animals. The extensive view of life thus acquired led to his celebrated elaboration of the pneumatic doctrine. Besides the *πνεῦμα ζωτικόν* and the *πνεῦμα ψυχικόν* of Erasistratus, Galen, like Athenæus, added a *πνεῦμα φυσικόν* which, resident in the liver, he endowed with the power (*δύναμις*) of nutrition, growth, secretion, reproduction, etc. Galen's conception of the circulation is worthy of mention. To his mind the venous blood, originating in the liver, travelled to the right side of the heart where a dual separation took place, the living portion proceeding to the left side of the heart, the dead portion being carried to the lungs, there to undergo a process of "refreshment" under the influence of the external pneuma. With the prophetic instinct of true genius, Galen suspected that the life-giving pneuma would some day be isolated from the air which held it. To Hippocrates all theorists have appealed, whether solidists, humorists, dynamists, animists or vitalists. All schools too have quoted Aristotle whose metaphysical or physiological studies were in turn adduced, according as a subjective or objective method of study was being advocated. But with the advent of Galen comes for the first time a theory that leaves no doubt as to its nature.

The mode in which Aristotle's teachings and discoveries

became transmitted to posterity forms a curious page in the annals of the history of philosophy. His scientific researches appear to have been preserved and diffused mainly by the activity of the Arabian school, while his metaphysics, reaching these Western shores some centuries before Arabian studies had spread hither, were already—possibly because of their inherent theistic tendencies and denial of chance—warmly debated in, if not embraced by, the early Christian Church.

At an early date the Fathers of the Church found themselves confronted with the difficulties of several perplexing questions concerning the nature of life. Accepting the biblical tradition of the *ψυχή*, they began to inquire into the further details of its nature. To Aristotle they turned as a guide; and when they read the Stagirite's teaching that man had a constructive, a sensory, a rational and other souls, the question arose as to whether these were merely expressions (*δυνάμεις*) of a unitary soul or whether the biblical *ψυχή* must be subdivided into these distinct components. This problem was debated with vigour, but the majority appear to have accepted the conception of a single soul, Origen, the Manichæans and the Gnostics being most prominent among their opponents.

St. Gregory of Nyssa (fl. 370 A.D.) set up three degrees of life, dividing the *δύναμις ζωτική* or vital force into the life of nutrition devoid of sensation, the life of sensation which is also nutritive, and the life of reason which being perfect includes the life of nutrition and sensation.

The doctrine of the union of *νοῦς* and *ψυχή* found an able advocate in St. Basil (329-379 A.D.), who conceived intellect as something originally planted or sown (*ἐγκατεσπαρμένον*) by the Holy Trinity within the soul. He thus believed the Soul to have a twofold power, vital (*ζωτικόν*) and rational (*λογιστικόν*) (3).

St. Augustine of Hippo (354-430 A.D.), the great opponent of the Manichæan doctrine of the separate existence of good and evil souls, ranks as the ablest vindicator of the Aristotelian teaching concerning the nature of life. In the *De quantitate animæ*, however, he adds to the souls of vegetable, animal, and intellectual activity, four other souls which culminate in the vision of God and in pure love. His cosmogony, moreover, is to a certain extent evolutionary; for him, the *anima vivificans* stands at the lowest rung of the ladder of life.

Philosophy thus merged with Theology, was destined to regain at length her former liberty. Stealthily secession

after secession was made from the mother Church, until the movement culminated in the misshapen growth of Scholasticism. This phase of philosophic history perhaps found its first opening in the teachings of John Scotus Erigena (fl. 850). His philosophy was a quaint combination of Platonic and Christian doctrines ; and so incomprehensible were his views that it may be assumed that the wrath poured down on him by orthodox Authority arose rather from the spirit of scepticism which he displayed than for the commission of definite heresy.

Meanwhile a new culture had begun to influence the development of Western thought ; for the centres of European philosophy, eager in their scepticism for anything new, were welcoming the now rapid spread of Arabian philosophy. This school, more properly Semitic than Arabian, did little to further the experimental side of biology, although its disciples won great renown for their Aristotelian philosophy tinged with native mysticism, and for their system of medicine and physics which a careful preservation of Aristotle's scientific work had afforded them. At the same time the teachings of the wandering Spaniards and Jews of this school took a definite hold on the current thought of Europe, rapidly hastening the dawn of the revival of independent inquiry, and tending no less to the encouragement of the objective method (Roger Bacon fl. about 1200) than to the preservation of the subjective method.

Sceptics began now to pour in from either side. The Franciscans came to the fore armed with the heretical doctrine of a plurality of souls. Thus, too, reasoned Duns Scot (fl. 1300) against Thomas Aquinas : " Since the body has form after the soul has left it, form and the soul are necessarily distinct " (3). Such wilful resistance to the received doctrine of the Church quickly roused the fury of orthodoxy. Œcumenical councils were held in rapid succession, denouncing all scepticism as heretical and finally forbidding the study of Arabian and Aristotelian philosophy. Whether because of this thunder from authority or through the more silent voice of the revival of learning, Aristotelianism fell to the ground. The year 1548, which saw the birth alike of the last Scholastic, the Spanish Jesuit Francisco Suarez (1548-1617), and of the first independent philosopher, the Italian martyr Giordano Bruno (1548-1600), marks the turning-point. The overthrow of Aristotelianism in theology and metaphysic found its equivalent in the rejection of Galenism by Natural Science. Little by little the implicit faith in Galen's infallibility had become shaken, and the

veil that but half concealed the expressions of dissatisfaction with long-accepted doctrines had been gradually drawn aside. Finally, in the sixteenth century, this conspicuous revival of learning marked a final revolt against the narrow-minded credulity of previous centuries. A renaissance it truly was ; Galen was fallen, Physiology was reborn.

This stimulus to independent thought was confined to no single country. Germany, France, Italy, Spain and England all produced men endowed with the revolutionary spirit.

Fernelius (1497-1558) led the way by abruptly separating the *Anima* or Soul from the Galenic pneuma. Argentieri (1513-1572) revived pre-Galenic doctrines with strangely altered significance. Others again, as Paracelsus, made the researches of the alchemists the starting-point of their theories.

Paracelsus (1493-1541)—less known by his real name, Bombast von Hohenheim—struck perhaps the most effective blow against the long-accepted infallibility of Galen. Following that of his master, Basil Valentine, his theory, essentially alchemistic, was founded on the search after the tincture, elixir and the quintessence of all things. To his mind, the Mosaic creation of the world from nothing clearly necessitated the pre-existence of a quintessence. This quintessence was conceived by Paracelsus to be of a double nature, the visible or earthly, and the invisible or astral, of which two parts everything living and lifeless is composed. Man is the midpoint of the universe, said Paracelsus, a microcosm to be studied in the centre of a surrounding macrocosm. As the fruit can only be regarded from the nature of the seed, so man can be comprehended solely from the world which preceded him. Man is made up of the twofold quintessence above described, the visible or bodily, consisting of sulphur, salts and mercury, and the invisible or spiritual. Paracelsus, however, with characteristic inconsistency, adds an *anima* or soul to the human *corpus spiritus*. This *anima* is the living breath of God. "As the body feeds on earth, the spirit on the stars," so the Paracelsian "soul feeds on Christ".

Jan Baptista van Helmont (1577-1644) may be said to have carried on and completed the work of Paracelsus. He advocated the famous doctrine of the archei derived from the master of alchemy who preceded him. Like the astral and earthly components of the Paracelsian quintessence, archeus and matter were said by van Helmont to be universal. All things, he declared, are alive in different degrees,

The archei, diffused through the tissues of organisms in living nature, build up their home by ferment action on other matter and direct the growth, movement and other functions of the part. Ferments cause the shaping, Blas the movement of matter. The stomach and spleen are the duumvirate. The former contains the great archeus which presides over the lesser and secondary archei and is dominated by the sensitive and mortal soul, the spirit of Paracelsus. A rational and immortal soul is added by van Helmont to the sensitive soul. These two souls, joined in marital equality, conjugal unity and by other quaint metaphorical ties, live together in the stomach, directing the organism in harmony. The archei when imperfect causes disease. They are ever trying to conform to the type of the seminal image (*imago seminalis*), which is the form whereof the vital breath (*aura vitalis*) is the matter.

To combat the reigning theories of principal and subsidiary archei, René Descartes (1596-1650) opposed the famous system on which subsequently were based the iatrophysical school of Borelli (1608-1679) and the iatrochemical school of Sylvius (1614-1672). He maintained that life, both human and animal, was a purely mechanical process and that the soul, which was absent in animals, did only that of which it was conscious, knew of what it thought and had no concern in vital activity. So revolutionary a standpoint could not but provoke a vigorous opposition, notably in Cambridge at the hands of Cudworth and Glisson. Ralph Cudworth (1617-1688) condemned the Cartesian denial of unconscious processes to the soul, and the mechanical explanation of the phenomena of life. In his attempt to steer a middle course between the debasement of soul and the rejection of mechanism, he established a universal plastic matter, intermediate between the world and God, immaterial and acting purposefully without will or reason. Even as this universal plastic nature is an inferior property of the soul of the world, so every human and animal soul has its plastic nature which bridges over the gulf between mechanism and thought. Francis Glisson (1597-1677) foreshadowed Leibnitz when, re-echoing Heraclitus, he proclaimed that everything that has substance and existence has activity. He considered the activity of life (*ἡ βίαρχία*) to be inherent not only in spiritual, but in material form. "Matter is not only capable of life but is also actually living." To this activity of substance are bound three faculties, perceptive, appetitive and motive. Nature, thus constituted with life and faculties has gradually developed her powers, until she

has formed the souls of animals which are and remain merely *modi materiæ* and therein contrast with the true substance of the human soul.

A still bolder challenge to the growing iatromechanical schools was made by Gottfried Wilhelm Leibnitz (1646-1676), who endeavoured to overthrow the strictures of Cartesian dualism by endowing every particle of matter with an active immaterial force—the monad. He supposed that central monads ruled over subsidiary monads, and that in the living body the central monad was the soul. He denied that the soul knew all its actions and maintained the indestructibility and evolution of monads, ascribing the interaction of soul and matter to a pre-established harmony. This conception of pre-established harmony was actively combated by Georg Ernst Stahl (1660-1734), the last famous champion of modern Animism. His system, foreshadowed in some manner by the versatile Frenchman, Claude Perrault (1613-1688), rapidly won over many adherents. He owed his professorial chair at Halle to Friedrich Hoffmann (1660-1742), to refute whose widely spread iatromechanical doctrines he devoted his life. Stahl taught that the body lives only for the soul which directly shapes it for its own ends, and that the soul, ignorant of many of its purposeful and rational actions because of the limitations of consciousness and memory, is the source of all mental and bodily activity, perpetually fighting against that onrush of physical and chemical activities which betokens death.

The bitter controversies which took place between the followers of Stahl and those of Borelli, Sylvius and Boerhave, brought home the conclusion that experiment alone contained the key to the mystery of life's nature. Thus physiology, which had received its first recognition at the hands of Galen and had again been prominently advocated by Harvey, at length obtained its lawful place during the first half of the last century. From Haller (1708-1777) dates the final establishment of experimental biology. The collection of isolated theories and long-forgotten discoveries within his *Elementa Physiologiæ Corporis Humani*, his own researches on the nature of irritability, and his contribution to the rival theories of epigenesis and evolution, all mark the dawn of a new epoch.

Once more came about a decentralisation of the vital principle. For the researches, which—first suggested by Glisson—were extended by Haller, and subsequently by Cullen, John Brown, Broussais, Fleming and others, into the irritability of muscle and the sensibility of nerve, had a

far-reaching influence on vitalistic doctrines. They made it evident that the great *anima* of Stahl was insufficient to account for those phenomena of life which were exhibited by isolated portions of fresh tissues. Already in the previous century this difficulty had been felt, and the appearances were then attributed to an "inherent tendency in the spirits and humours of the tissue in question". Partly resulting from the inadequacy of such explanation, and partly owing to the rife spirit of speculation of the day, a vast mushroom-growth of vitalism appeared at the close of the eighteenth century. In the school at Montpellier founded by Sauvages, Theophile de Bordeu (1722-1776) refused to accept Stahl's unitary conception of soul and vital principle. The importance of the all-powerful *anima* dwindled, and its functions became appropriated by vital forces resident in the various tissues of the body. Bordeu's successor, Paul Joseph Barthez (1734-1806), not only opposed the animism of Stahl and the teaching of mechanism but bitterly attacked Haller's theories which had led Bordeu to give to every organ its peculiar sensibility. Louis Dumas (1765-1813) set up a *force hypermécannique* as the unknown and unknowable principle of life, a standpoint somewhat similar to that adopted by the great vitalist Xavier Bichat, at Paris. Lordat distinguished three distinct parts in man, material, vital and psychical, and maintained that rational life resulted from a superposition of the psychical on the material and vital elements. Meanwhile in Germany, where vitalism was not so prominent, Reil (1759-1813) clearly stated the notion of a special force peculiar to living substance, which, arising from a peculiar combination of the elements, controlled the play of mechanical forces; while Blumenbach remained to utilise a *nisus formativus* in the same loose fashion as the doctrines of nervous fluid and of stimulation were being employed in England.

Experiment, however, running like a tortoise beside swift-footed Theory, was rapidly outstripping it in the race for Truth. The investigations of Galvani, von Humboldt, Priestley, Lavoisier and Charles Bell could not fail to convince physiologists how uncertain and indefinite were their conceptions of vital force. A few of the old school yet lingered. Thus Treviranus (1779-1837) established a hypothesis on the basis of a powerful indestructible formless material universally accompanying vital phenomena; and Autenrieth conceived an imponderable independent force which with the blood ebbed and flowed between the tissues. Ultimately, however, with the appearance of Johannes

Müller, dawned the present age of patient investigation and physiological experiment.

While Vitalism was still at its height, Johannes Müller, the father of modern physiology, began his monumental work of collecting the past writings on his subject with an ability and a thoroughness the like of which had not been employed since the days of Haller. Calling to his aid, as it has been said, not one but every method of research, Müller next endeavoured to sum up his laborious inquiries into the nature of life in a far-reaching vitalistic theory. His opinions certainly changed as years passed by; but throughout his life Müller seems to have argued that, since to him no difference was manifest between the elementary composition of living and recently dead bodies, a principle, having "the nature of force rather than of imponderable matter" must necessarily be introduced to explain this want of difference. By further reasoning, Müller inferred that all matter contained in a latent state both the vital and mental principles. Nevertheless he intended to explain life by mechanical principles, for to his mind vital force followed the lines of physical and chemical forces, however different it might be from these forces themselves (4).

While in England Sharpey (a pupil, like Müller, of Rudolphi), Bowman and Goodsir were pursuing their anatomical investigations, in Germany Schleiden, followed in 1839 by Schwann, proclaimed a new biological unit—the cell. Naturally carried away by the importance of his discovery, Schwann was led to look on growth as a kind of crystallisation-process in the cell, and to give a quasi-mechanical explanation of vital phenomena, diametrically opposed to the vitalism of his time. These views were vigorously denounced by E. H. Weber and by Virchow. But one of the most fatal blows (5) to the dying conception of the vital principle was now given in 1845 by J. Robert Mayer, who introduced the far-reaching conception of the indestructibility of force. In 1859 the first edition of Darwin's *Origin of Species* was published.

This rapid succession of revolutionary discoveries made a reaction towards mechanism clearly imminent. J. R. Mayer in 1845 and E. W. Weber in 1858 maintained the movements of a living as of a lifeless body to be dependent on forces acting on it from without. Weber's pupil, Carl Ludwig, and Müller's school of rising physiologists in 1847 banded themselves together for an avowed "*Befreiungswerk aus dem Vitalismus*". A few remained, like Liebig, Wagner and Lotze, to assert the existence of a special vital principle,

Liebig standing alone when he proclaimed that in the living body chemical and physical forces acted under the influence of a non-chemical force or cause. So might he preach, but no physiologist would lend an ear. Eagerness for a unitary conception of living and lifeless nature called all to experiment and converted all to Mechanism. Moleschott, Vogt, Büchner (6) and Häckel (7) hurried forth with views of the crudest materialism. In 1853 Rudolf Wagner was forced to cease his *Physiologische Briefe*, so ill-received were his protests against materialism. His offer to meet Ludwig at the Göttingen Congress of Physiologists in 1854 was frustrated (according to his own statement) by illness. Certainly it is said that not one physiologist out of 500 present raised his voice in favour of a special soul-substance. During the same year Wagner published his *Glaube und Wissen*, wherein he stated that as regards knowledge he followed the teachings of science, but that his faith he shared with the humblest charcoal-burner. This met Vogt's fiercely polemic reply which he entitled *Köhlerglaube und Wissenschaft*. Here the bitter fight ended, and with Rudolf Wagner the last of the ultra-vitalists passed away (8).

Meanwhile in France, Claude Bernard was pursuing his famous researches, and bringing his critical acumen to bear in the final overthrow of eighteenth-century vitalism. He predicted the future assimilation and agreement of the vitalistic and mechanical theories of life (9), and, like his master Magendie, vehemently opposed the current doctrines of the Parisian school. Wagner's *Handwörterbuch der Physiologie* contains an introductory chapter by Hermann Lotze, entitled "Leben-Lebenskraft". An examination of Lotze's views scarcely comes within the scope of this essay, but, if only because of their bold independence, they deserve passing mention here. Lotze is indeed a thorough-going mechanist so far as the a-psychical processes of life are concerned. But, like Descartes, he finds himself compelled to conclude that "the living animal body considered as a mechanism is distinguished from all other mechanisms by the possession of a principle of immanent disturbances which in force and frequency follow no mathematical law" (10). This conception of a soul is developed to a marked degree in Lotze's later writings, where also the vigour of his attacks on vitalism is correspondingly diminished. In certain works he had hesitated to admit the rule of the soul (unconscious of the process by long habit) over metabolism and development (11). In after years, however, the peculiar relation which he held to subsist between Meta-

physics and Psychology, the necessity of an inner unity within consciousness and of a principle which directs the evolution of the individual and species, led to the establishment of a thorough-going Spiritualism. A further examination of these peculiar views is here impossible. At the hands of Virchow (12) (13) they have received a criticism of the most vigorous character. Another critic, Hartmann, has rightly said that Lotze never utters an Aye without an equally emphatic Nay. Lotze's change of standpoint, his subtlety and self-criticism, all contribute in defying a concise presentations of his views (48).

Lionel Beale has sought a purely vitalistic theory to overthrow the raging materialism of his time. He has periodically continued the publication of his views during the last twenty-five years. He argues that there is something unknown, some mysterious force or power, which works in living matter only, is only temporarily associated with that matter, and is identical with a something which "chemists admit that . . . dead matter does not possess," which "transforms force and rearranges the elements of matter" (14).

In the end the weapon, by which that earnest band of Berlin physiologists had hoped to crush their opponents, recoiled like a boomerang on their own heads. The researches of Ludwig on salivary and renal secretion, followed more recently by those of Heidenhain on the formation of lymph and assimilation of food, and of Pflüger on internal respiration, afforded convincing proof of the complexity even of those vital processes which had hitherto been considered simple, and of the extreme difficulties which a mechanical explanation involved. Notwithstanding this undercurrent of changing thought, no return to vitalism can be said to have openly taken place until the years 1887 and 1888, when Bunge published his lectures on physiological and pathological chemistry, and Rindfleisch delivered his *Rectoratsrede* at Würzburg. The latter boldly advocates a "Neo-vitalism" which "has developed quite independently of those old vitalistic theories," which "recognises vital force only in its most intimate union with a life-substance that belongs to it. The theory honestly endeavours to explain vital phenomena by the physico-chemical constitution of life-substance . . . It does not, however, hide from itself that apart from the phenomena of consciousness there are facts which will offer insurmountable obstacles to the investigation." A somewhat similar standpoint is upheld by Bunge in the preface to his *Lehrbuch der Physiolog-*

ischen und Pathologischen Chemie. He proclaims that we do not see life, but only its results. There is something which to his mind is beyond the mechanically explained phenomena of respiration, circulation, nutrition, locomotion and development, a something which "vitalism will assuredly reveal in the face of the failure of chemistry and physics". It is Bunge's opinion that psychology alone can explain physiology. Study of the internal world must precede that of the external. This and this only is the path, he declares, by which the one riddle of life, Activity, may be solved.

(To be continued.)